Magnetoelastic Coupling in URu_2Si_2 from Dilatometry in High Fields

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Introduction

Despite decades of research, URu_2Si_2 remains among the most fascinating and puzzling of correlated electron systems [1]. At the focus of the puzzle is the appearance of an ordered phase, heralded by a large specific heat anomaly at T_{HO} = 17 K. The nature of the order underlying this phase remains ambiguous, hence the term "hidden order" (HO) phase. Time reversal symmetry and magnetoelastic correlations are here probed by means of high-resolution volume dilatometry at cryogenic temperatures and magnetic fields large enough to suppress the hidden order state at H_{HO}(T = 0.66 K) ~35 T.

Experimental

The magnetostriction was measured with an optical fiber Bragg grating (FBG) technique in pulsed and DC magnetic fields. The FBG interrogation in pulsed fields is done with a SLED broadband light source, a spectrometer, and a line array camera running at 46 KHz. In DC magnetic fields we use a commercial swept-wavelength laser Hyperion® interrogator by Micron Optics, running at 5 KHz. [2]

Results and Discussion

We report a significant crystal lattice volume magnetostriction at and above H_{HO}(T), and even above T_{HO}, possibly a consequence of field-induced *f*-electron localization, and hysteresis at some high field phase boundaries that confirm volume involvement. We investigate in detail the magnetostriction and magnetization as the temperature is reduced over two decades from 50 K where the system is paramagnetic, to 0.5 K in the realms of the hidden order state. We find a dominant quadratic-in-field dependence $\Delta L/L \propto H^2$, a result consistent with a state that is symmetric under time reversal. The data shows, however, an incipient yet unmistakable asymptotic approach to linear ($\Delta L/L \propto 1\text{-}H/H_0$) at the lowest temperatures that is interpreted as evidence in support of multipolar order.

Acknowledgements

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References

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[3] Wartenbe M., et al., arXiv:1812.02798

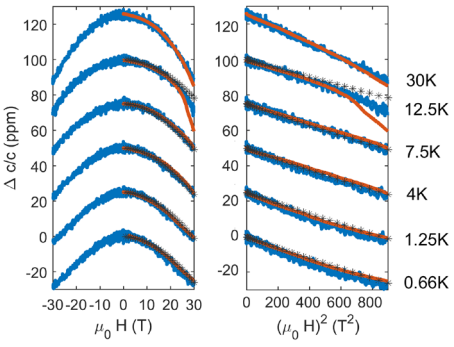

Fig.2 Axial magnetostriction Δc/c vs H (left panel) and vs H^2 (right panel) showing an asymptotic approach to linear-in-H behavior as the field increases at the lowest temperatures.

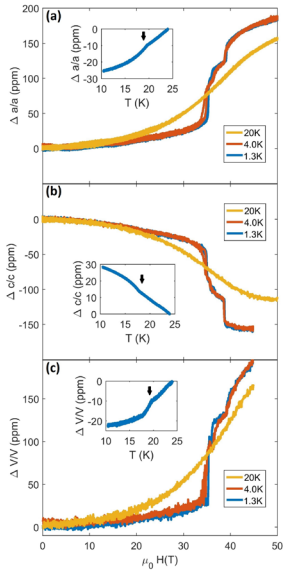

Fig.1 (a) Transverse and (b) axial magnetostriction of URu_2Si_2 for H//c-axis measured in pulsed magnetic fields. (c) Volume magnetostriction